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# ESTIMATING SLOPE PERCENT FOR LAND MANAGEMENT FROM AERIAL PHOTOS

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## ABSTRACT

Describes and discusses a simple method of measuring slope on aerial photos of the type available to most land managers. Comparative data indicate photo estimates of average slope percent for an area are reliable and are far less costly than estimates made from measurements on the ground.

## INTRODUCTION

"Can I measure slope percent on aerial photos? If so, how do the measurements compare in reliability and cost with those made on the ground?"

Land managers are taking an increasing interest in answers to questions such as these. Few inventory surveys of wild lands--whether for timber, grazing, water, recreation, or wildlife--neglect measurement of slope percent, but the advantages and the ease of photo measurement are not widely known.

First, the matter of reliability of estimates. Evidence from 322 paired photo and ground measurements on the type of photos readily available to land managers indicates that for most inventory purposes photo estimates of slope do not vary significantly from those made on the ground. Photo measurements are especially close to ground measurements on areas where the ground is not obscured by trees. At 34 locations, where the ground was visible on the aerial photos and the ends of the slope line used for ground measurement could be located precisely on the photos, the two sets of measurements showed little difference.[1] Although the variation between individual ground and photo readings is somewhat greater where tree cover obscures the ground on photos, the differences between these measurements at 187 locations still were not significant.[2]

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[1] Correlation coefficient was 0.941. The mean slope percent and standard errors for photo and ground measurements were 19.50 ±2.94 and 19.12 ±2.51, respectively.

These data highlight some results of research into the accuracy of slope measurements for land management purposes. The 322 paired sets of field and office measurements mentioned above were taken by several investigators working independently on different management and research projects in the Intermountain and Pacific Northwest areas. Other findings of this research, such as the close similarity of results by different photo interpreters working under different conditions, are described more fully in a companion report.[3]

Reliability, however, is only one factor in sampling efficiency. What is the saving in cost?

On almost all inventory surveys, estimates of slope made on the kind of photos usually available to land managers are much less expensive than ground estimates. This is indicated from a comparison of the number of measurements that can be made per man-hour. Experience indicates that photo measurements of slope can be made at a sustained rate of 5 to 10 per man-hour--a rate that is practically unaffected by ground conditions. Field measurements usually require far more time. On intensive surveys with samples only a few chains apart, a two-man survey party may make several slope measurements per hour. But on extensive surveys, based on samples several miles apart in rugged or inaccessible country, only a single slope measurement may result from a whole day's work by a two-man crew.

Photo measurement is of particular advantage on sites where several ground measurements must be averaged to obtain an estimate of general slope over a long distance. For example, when average slope is needed over one-fourth mile or more of uneven or forested terrain, lack of visibility usually means several short ground observations must be made and averaged. The time required for making such a series of observations is far longer than would be required for estimating average slope percent from the single set of photo measurements.

The necessity of going on the ground to gather additional kinds of information is often given as a reason for not using photo measurements of slope. However, the cost of ground measurement always limits and reduces the intensity of sampling and, therefore, the reliability of these estimates. When more reliable slope estimates are needed, photo measurement provides opportunity to increase the intensity of sampling at a fraction of the cost of additional fieldwork.

The following pages describe in detail the relatively simple procedures recommended for photo measuring of slope on forest and other wild land inventories. These techniques are simpler than first glance would suggest. They can be learned much easier than the measurement of tree heights on photos. Men familiar with aerial photos can learn to make acceptably precise slope measurements in five or six 2-hour training periods.

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[2] Although the correlation dropped to 0.857, the mean slope percents and their standard errors remained very close--32.48 ± 1.38 and 33.32 ± 1.45 for photo and ground measurements, respectively.

[3] Moessner, Karl E. Learning to estimate stand volume from aerial photos. U.S. Forest Serv. Intermountain Forest and Range Expt. Sta. Res. Note INT-25, 4 pp., illus. 1964.

## MEASUREMENT TECHNIQUES

Several instruments, such as the Stereo Slope Meter, the slope measuring parallax wedge, and various floating line devices, have been especially designed for measuring slope on aerial photos and have been well described.[4] None of these instruments, however, is easier to use on photos nor is likely to produce more precise readings than can be obtained from the simple parallax wedge or the parallax bar.

Slope percent obtained from aerial photos is a combination of two measurements: elevation difference and horizontal distance. Its formula is:

$$\text{Slope percent} = \frac{\text{elevation difference}}{\text{horizontal distance}} \times 100.$$

Since elevation difference is determined by parallax measurements, the stereopair of photos must first be set up for such measurement.[5] Regardless of whether parallax wedge or parallax bar is to be used, this setup consists of properly orienting and taping photos to the desk to prevent their movement during measurement. The photos are studied under stereo viewers, and a line is drawn through the location in the direction of steepest slope. Two points are selected on this line straddling the location (fig. 1, location A). These are usually 500 or more feet apart, but a shorter distance may be used on large-scale photos or where opportune photo detail facilitates measurement.

The parallax difference between the two points is measured to the nearest 0.001 inch if a parallax wedge is used, or to the nearest 0.01 millimeter when using a parallax bar. The horizontal distance between the two points is then measured on the photo by means of a rule reading in 0.001 foot. Parallax wedges designed for this work have rules of this type printed on them. Both parallax difference and horizontal distance are converted to feet on the ground at the local scale of the aerial photos. Computation of difference in elevation is simplified by use of a standard table of parallax factors (table 1).

The following example, measured on figure 1, location A, illustrates this procedure:

Flying height (H-h) = 11,000 feet
Parallax (P) = 4.0 inches
Photo scale reciprocal (PSR) = 11,000
Parallax difference (dp) = 0.038 inch
Distance between points = 0.026 foot
Parallax factor = 2.7 feet per 0.001-inch dp (table 1)
Elevation difference is $38 \times 2.7 = 103$ feet
Distance between points is $26 \times 11 = 286$ feet

$$\text{Slope percent} = \frac{103}{286} \times 100 = 36.0.$$

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[4] American Society of Photogrammetry. Manual of photographic interpretation. Pp. 154-156, illus. 1960.

[5] Moessner, Karl E., and Earl J. Rogers. Parallax wedge procedures in forest surveys. U.S. Forest Serv. Intermountain Forest and Range Expt. Sta. Misc. Pub. 15, 22 pp., illus. 1957.

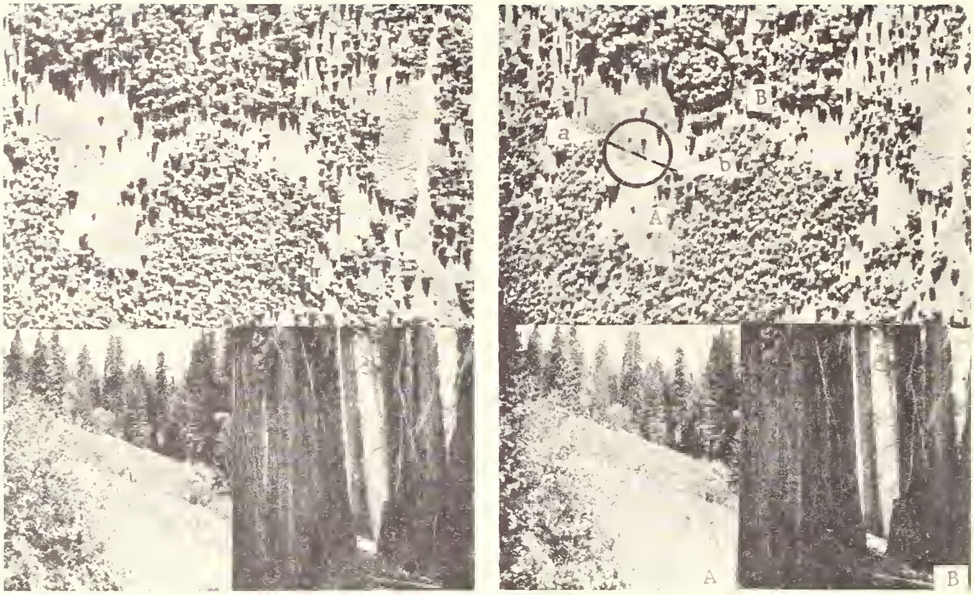

Figure 1.--Slope measurements in open (A) and in wooded area (B). Line a-b is drawn through center of location A in the direction of the steepest slope with ends marked by trees at a and b. The measured parallax difference is 0.038 inch, and the measured length of line is 0.026 foot. This results in a 36-percent slope. At location B the general slope of the ridgetop is measured at 20 percent, but the side slopes are somewhat steeper. Under these conditions field and photo measurements may disagree in direction and therefore in percent of slope.

Where parallax measurements are made for slope only, computations can be speeded up by use of specialized parallax factors (table 2) obtained by dividing the parallax factor (from table 1) by $\frac{\text{PSR}}{1,000}$. Using the same measurements obtained from figure 1:

Focal length = 12 inches
Parallax (P) = 4 inches.

From table 2, the parallax factor is 0.250 foot per 0.001-inch dp:

$$\text{Elevation difference} = 38 \times 0.25 = 9.5 \text{ feet}$$
$$\text{Distance between points} = 26 \text{ feet}$$
$$\text{Slope percent} = \frac{9.5}{26} \times 100 = 36.5.$$

The slight difference in results of the two computations is due to rounding of tabular data; both results are very close to the 35 percent measured by Abney level on the ground.

When measurements are made in millimeters by parallax bar, the specialized parallax factors from table 2 are further converted to read in feet per 0.01 millimeter dp (table 3). Otherwise, computations remain the same.

Whenever slopes are measured on aerial photos, the ends of the slope line must be selected, and this involves a certain amount of photo interpretation. When the sample occurs in forest, the interpreter may have difficulty locating the ground. Then it is often more precise to measure points in the open outside the sample if the slope appears the same. In figure 2, location A, the slope might be measured on the cutover area above or to one side of the location (1), or the slope line might be extended from the cutting above (a) through the location to the cutting below (b). Skill in making these decisions can be acquired only through experience.

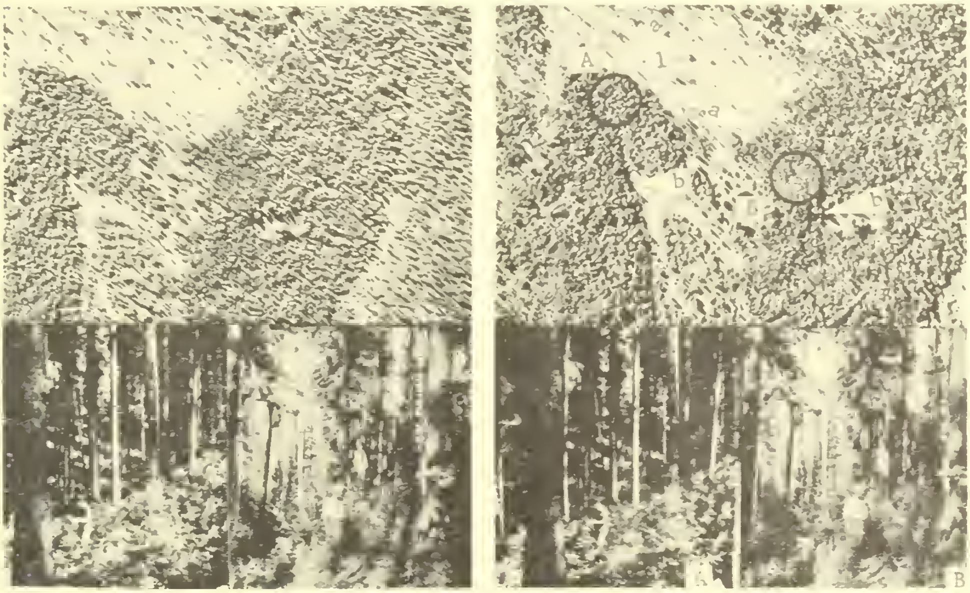

Figure 2.--Slope measurements on forested plots are made between openings wherever possible. Slope at location A, which occurs in the forest, would probably be measured either in the cutover area at point 1, or between points a and b, which lie in the cutover above and below location A, respectively. However, if the forest canopy has no openings, a close approximation of the ground slope could be obtained from measurements made on the treetops near points a and b. Location B would be measured from a to b in the same manner.

Photo data--Flying height (H-h)--11,000 feet
PSR--16,000; F.L.--$8\frac{1}{4}$ inches
Parallax (P)--3.6 inches.

## Table 1.

Parallax factors by parallax (P) and flying height (H-h)

| Parallax: (P) or (P+dp) (inches) | Flying height (H-h) in thousands of feet | | | | | | | | | | | | | | | | | | Parallax (P) or (P+dp) (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 | 10.5 | |
| | Parallax factor (ho) in feet per 0.001 inch (dp) | | | | | | | | | | | | | | | | | | |
| 1.5 | 1.3 | 1.7 | 2.0 | 2.3 | 2.7 | 3.0 | 3.3 | 3.7 | 4.0 | 4.3 | 4.7 | 5.0 | 5.3 | 5.6 | 6.0 | 6.4 | 6.7 | 7.0 | 1.5 |
| 1.6 | 1.3 | 1.6 | 1.9 | 2.2 | 2.5 | 2.8 | 3.1 | 3.4 | 3.7 | 4.0 | 4.3 | 4.7 | 5.0 | 5.3 | 5.6 | 6.0 | 6.3 | 6.6 | 1.6 |
| 1.7 | 1.2 | 1.5 | 1.8 | 2.1 | 2.3 | 2.6 | 2.9 | 3.2 | 3.5 | 3.8 | 4.1 | 4.4 | 4.7 | 5.0 | 5.3 | 5.6 | 5.9 | 6.2 | 1.7 |
| 1.8 | 1.1 | 1.4 | 1.7 | 2.0 | 2.2 | 2.5 | 2.8 | 3.0 | 3.3 | 3.6 | 3.9 | 4.2 | 4.4 | 4.7 | 5.0 | 5.3 | 5.5 | 5.8 | 1.8 |
| 1.9 | 1.1 | 1.3 | 1.6 | 1.9 | 2.1 | 2.4 | 2.6 | 2.9 | 3.1 | 3.4 | 3.7 | 4.0 | 4.2 | 4.5 | 4.7 | 5.0 | 5.2 | 5.5 | 1.9 |
| 2.0 | 1.0 | 1.2 | 1.5 | 1.8 | 2.0 | 2.3 | 2.5 | 2.7 | 3.0 | 3.2 | 3.5 | 3.8 | 4.0 | 4.2 | 4.5 | 4.7 | 5.0 | 5.2 | 2.0 |
| 2.1 | 1.0 | 1.2 | 1.4 | 1.7 | 1.9 | 2.1 | 2.4 | 2.6 | 2.8 | 3.1 | 3.3 | 3.6 | 3.8 | 4.0 | 4.3 | 4.5 | 4.8 | 5.0 | 2.1 |
| 2.2 | 0.9 | 1.1 | 1.4 | 1.6 | 1.8 | 2.0 | 2.3 | 2.5 | 2.7 | 2.9 | 3.2 | 3.4 | 3.6 | 3.9 | 4.1 | 4.3 | 4.5 | 4.8 | 2.2 |
| 2.3 | 0.9 | 1.1 | 1.3 | 1.5 | 1.7 | 2.0 | 2.2 | 2.4 | 2.6 | 2.8 | 3.0 | 3.2 | 3.5 | 3.7 | 3.9 | 4.1 | 4.3 | 4.6 | 2.3 |
| 2.4 | 0.8 | 1.0 | 1.3 | 1.4 | 1.7 | 1.9 | 2.1 | 2.3 | 2.5 | 2.7 | 2.9 | 3.1 | 3.3 | 3.5 | 3.7 | 3.9 | 4.1 | 4.4 | 2.4 |
| 2.5 | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 | 2.6 | 2.8 | 3.0 | 3.2 | 3.4 | 3.6 | 3.8 | 4.0 | 4.2 | 2.5 |
| 2.6 | 0.8 | 1.0 | 1.2 | 1.3 | 1.5 | 1.7 | 1.9 | 2.1 | 2.3 | 2.5 | 2.7 | 2.9 | 3.1 | 3.3 | 3.5 | 3.7 | 3.8 | 4.0 | 2.6 |
| 2.7 | 0.7 | 0.9 | 1.1 | 1.3 | 1.5 | 1.7 | 1.8 | 2.0 | 2.2 | 2.4 | 2.6 | 2.8 | 3.0 | 3.2 | 3.3 | 3.5 | 3.7 | 3.9 | 2.7 |
| 2.8 | 0.7 | 0.9 | 1.1 | 1.3 | 1.4 | 1.6 | 1.8 | 2.0 | 2.1 | 2.3 | 2.5 | 2.7 | 2.9 | 3.0 | 3.2 | 3.4 | 3.6 | 3.7 | 2.8 |
| 2.9 | 0.7 | 0.9 | 1.0 | 1.2 | 1.4 | 1.6 | 1.7 | 1.9 | 2.1 | 2.2 | 2.4 | 2.6 | 2.8 | 2.9 | 3.1 | 3.3 | 3.4 | 3.6 | 2.9 |
| 3.0 | 0.7 | 0.8 | 1.0 | 1.2 | 1.3 | 1.5 | 1.7 | 1.8 | 2.0 | 2.2 | 2.3 | 2.5 | 2.7 | 2.8 | 3.0 | 3.2 | 3.3 | 3.5 | 3.0 |
| 3.1 | 0.6 | 0.8 | 1.0 | 1.1 | 1.3 | 1.5 | 1.6 | 1.8 | 1.9 | 2.1 | 2.2 | 2.4 | 2.6 | 2.7 | 2.9 | 3.1 | 3.2 | 3.4 | 3.1 |
| 3.2 | 0.6 | 0.8 | 0.9 | 1.1 | 1.2 | 1.4 | 1.6 | 1.7 | 1.8 | 2.0 | 2.2 | 2.3 | 2.5 | 2.7 | 2.8 | 3.0 | 3.1 | 3.3 | 3.2 |
| 3.3 | 0.6 | 0.8 | 0.9 | 1.1 | 1.2 | 1.4 | 1.5 | 1.7 | 1.8 | 2.0 | 2.1 | 2.3 | 2.4 | 2.6 | 2.7 | 2.9 | 3.0 | 3.2 | 3.3 |
| 3.4 | 0.6 | 0.7 | 0.9 | 1.0 | 1.2 | 1.3 | 1.5 | 1.6 | 1.7 | 1.9 | 2.1 | 2.2 | 2.3 | 2.5 | 2.6 | 2.8 | 2.9 | 3.1 | 3.4 |
| 3.5 | 0.6 | 0.7 | 0.9 | 1.0 | 1.1 | 1.3 | 1.4 | 1.6 | 1.7 | 1.9 | 2.0 | 2.1 | 2.3 | 2.4 | 2.6 | 2.7 | 2.8 | 3.0 | 3.5 |
| 3.6 | 0.6 | 0.7 | 0.8 | 1.0 | 1.1 | 1.3 | 1.4 | 1.5 | 1.6 | 1.8 | 2.0 | 2.1 | 2.2 | 2.4 | 2.5 | 2.6 | 2.8 | 2.9 | 3.6 |
| 3.7 | 0.5 | 0.7 | 0.8 | 0.9 | 1.1 | 1.2 | 1.4 | 1.5 | 1.6 | 1.8 | 1.9 | 2.0 | 2.2 | 2.3 | 2.4 | 2.6 | 2.7 | 2.8 | 3.7 |
| 3.8 | 0.5 | 0.7 | 0.8 | 0.9 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.7 | 1.8 | 2.0 | 2.1 | 2.2 | 2.4 | 2.5 | 2.6 | 2.8 | 3.8 |
| 3.9 | 0.5 | 0.6 | 0.8 | 0.9 | 1.0 | 1.2 | 1.3 | 1.4 | 1.5 | 1.7 | 1.8 | 1.9 | 2.1 | 2.2 | 2.3 | 2.4 | 2.6 | 2.7 | 3.9 |
| 4.0 | 0.5 | 0.6 | 0.8 | 0.9 | 1.0 | 1.1 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.9 | 2.0 | 2.1 | 2.3 | 2.4 | 2.5 | 2.6 | 4.0 |
| 4.1 | 0.5 | 0.6 | 0.7 | 0.9 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.6 | 1.7 | 1.8 | 2.0 | 2.1 | 2.2 | 2.3 | 2.4 | 2.5 | 4.1 |
| 4.2 | 0.5 | 0.6 | 0.7 | 0.8 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.7 | 1.8 | 1.9 | 2.0 | 2.1 | 2.3 | 2.4 | 2.5 | 4.2 |
| 4.3 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 | 1.1 | 1.3 | 1.3 | 1.5 | 1.6 | 1.7 | 1.9 | 2.0 | 2.0 | 2.2 | 2.3 | 2.4 | 4.3 |
| 4.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 | 1.1 | 1.2 | 1.3 | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 | 2.0 | 2.2 | 2.3 | 2.4 | 4.4 |

Flying height (H-h) in thousands of feet

| Inches | 11.0 | 11.5 | 12.0 | 12.5 | 13.0 | 13.5 | 14.0 | 14.5 | 15.0 | 15.5 | 16.0 | 16.5 | 17.0 | 17.5 | 18.0 | 18.5 | 19.0 | 19.5 | Inches |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Parallax factor (ho) in feet per 0.001 inch (dp) | | | | | | | | | | | | | | | | | | |
| 1.5 | 7.3 | 7.7 | 8.0 | 8.3 | 8.7 | 9.0 | 9.3 | 9.7 | 10.0 | 10.3 | 10.7 | 11.0 | 11.3 | 11.6 | 12.0 | 12.4 | 12.7 | 13.0 | 1.5 |
| 1.6 | 6.9 | 7.2 | 7.5 | 7.8 | 8.1 | 8.5 | 8.7 | 9.0 | 9.4 | 9.7 | 10.0 | 10.3 | 10.6 | 11.0 | 11.2 | 11.6 | 11.8 | 12.2 | 1.6 |
| 1.7 | 6.5 | 6.8 | 7.1 | 7.3 | 7.6 | 7.9 | 8.2 | 8.5 | 8.8 | 9.1 | 9.4 | 9.7 | 10.0 | 10.3 | 10.6 | 10.8 | 11.2 | 11.4 | 1.7 |
| 1.8 | 6.1 | 6.4 | 6.7 | 6.9 | 7.2 | 7.5 | 7.8 | 8.1 | 8.3 | 8.6 | 8.9 | 9.2 | 9.5 | 9.7 | 10.0 | 10.3 | 10.6 | 10.8 | 1.8 |
| 1.9 | 5.8 | 6.1 | 6.3 | 6.6 | 6.8 | 7.1 | 7.4 | 7.7 | 7.9 | 8.2 | 8.4 | 8.7 | 9.0 | 9.2 | 9.5 | 9.7 | 10.0 | 10.2 | 1.9 |
| 2.0 | 5.5 | 5.8 | 6.0 | 6.3 | 6.5 | 6.7 | 7.0 | 7.3 | 7.5 | 7.8 | 8.0 | 8.3 | 8.5 | 8.8 | 9.0 | 9.3 | 9.5 | 9.8 | 2.0 |
| 2.1 | 5.2 | 5.5 | 5.7 | 5.9 | 6.2 | 6.4 | 6.7 | 6.9 | 7.1 | 7.4 | 7.6 | 7.9 | 8.1 | 8.3 | 8.6 | 8.8 | 9.0 | 9.3 | 2.1 |
| 2.2 | 5.0 | 5.2 | 5.5 | 5.7 | 5.9 | 6.1 | 6.4 | 6.6 | 6.8 | 7.0 | 7.3 | 7.5 | 7.7 | 7.9 | 8.2 | 8.4 | 8.6 | 8.9 | 2.2 |
| 2.3 | 4.8 | 5.0 | 5.2 | 5.4 | 5.7 | 5.9 | 6.1 | 6.3 | 6.5 | 6.7 | 7.0 | 7.2 | 7.4 | 7.6 | 7.8 | 8.0 | 8.3 | 8.5 | 2.3 |
| 2.4 | 4.6 | 4.8 | 5.0 | 5.2 | 5.4 | 5.6 | 5.8 | 6.0 | 6.2 | 6.4 | 6.7 | 6.9 | 7.1 | 7.3 | 7.5 | 7.7 | 7.9 | 8.1 | 2.4 |
| 2.5 | 4.4 | 4.6 | 4.8 | 5.0 | 5.2 | 5.4 | 5.6 | 5.8 | 6.0 | 6.2 | 6.4 | 6.6 | 6.8 | 7.0 | 7.2 | 7.4 | 7.6 | 7.8 | 2.5 |
| 2.6 | 4.2 | 4.4 | 4.6 | 4.8 | 5.0 | 5.2 | 5.4 | 5.6 | 5.8 | 6.0 | 6.2 | 6.3 | 6.5 | 6.7 | 6.9 | 7.1 | 7.3 | 7.5 | 2.6 |
| 2.7 | 4.1 | 4.3 | 4.4 | 4.6 | 4.8 | 5.0 | 5.2 | 5.4 | 5.6 | 5.7 | 5.9 | 6.1 | 6.3 | 6.5 | 6.7 | 6.9 | 7.0 | 7.3 | 2.7 |
| 2.8 | 3.9 | 4.1 | 4.3 | 4.5 | 4.6 | 4.8 | 5.0 | 5.2 | 5.4 | 5.5 | 5.7 | 5.9 | 6.1 | 6.3 | 6.4 | 6.6 | 6.8 | 7.0 | 2.8 |
| 2.9 | 3.8 | 4.0 | 4.1 | 4.3 | 4.5 | 4.6 | 4.8 | 5.0 | 5.2 | 5.3 | 5.5 | 5.7 | 5.9 | 6.0 | 6.2 | 6.4 | 6.6 | 6.7 | 2.9 |
| 3.0 | 3.7 | 3.8 | 4.0 | 4.2 | 4.3 | 4.5 | 4.7 | 4.9 | 5.0 | 5.2 | 5.3 | 5.5 | 5.7 | 5.8 | 6.0 | 6.2 | 6.3 | 6.5 | 3.0 |
| 3.1 | 3.5 | 3.7 | 3.9 | 4.0 | 4.2 | 4.3 | 4.5 | 4.7 | 4.8 | 5.0 | 5.2 | 5.3 | 5.5 | 5.6 | 5.8 | 6.0 | 6.1 | 6.3 | 3.1 |
| 3.2 | 3.4 | 3.6 | 3.7 | 3.9 | 4.1 | 4.2 | 4.4 | 4.5 | 4.7 | 4.8 | 5.0 | 5.1 | 5.3 | 5.4 | 5.6 | 5.8 | 5.9 | 6.1 | 3.2 |
| 3.3 | 3.3 | 3.5 | 3.6 | 3.8 | 3.9 | 4.1 | 4.3 | 4.4 | 4.5 | 4.7 | 4.8 | 5.0 | 5.2 | 5.3 | 5.5 | 5.6 | 5.7 | 5.9 | 3.3 |
| 3.4 | 3.2 | 3.4 | 3.5 | 3.7 | 3.8 | 4.0 | 4.1 | 4.3 | 4.4 | 4.6 | 4.7 | 4.8 | 5.0 | 5.1 | 5.3 | 5.4 | 5.6 | 5.7 | 3.4 |
| 3.5 | 3.1 | 3.3 | 3.4 | 3.6 | 3.7 | 3.9 | 4.0 | 4.1 | 4.3 | 4.4 | 4.6 | 4.7 | 4.9 | 5.0 | 5.1 | 5.3 | 5.4 | 5.6 | 3.5 |
| 3.6 | 3.0 | 3.2 | 3.3 | 3.5 | 3.6 | 3.8 | 3.9 | 4.0 | 4.2 | 4.3 | 4.4 | 4.6 | 4.7 | 4.9 | 5.0 | 5.1 | 5.3 | 5.4 | 3.6 |
| 3.7 | 3.0 | 3.1 | 3.2 | 3.4 | 3.5 | 3.7 | 3.8 | 3.9 | 4.0 | 4.2 | 4.3 | 4.5 | 4.6 | 4.7 | 4.9 | 5.0 | 5.1 | 5.3 | 3.7 |
| 3.8 | 2.9 | 3.0 | 3.2 | 3.3 | 3.4 | 3.6 | 3.7 | 3.8 | 3.9 | 4.1 | 4.2 | 4.3 | 4.5 | 4.6 | 4.7 | 4.9 | 5.0 | 5.1 | 3.8 |
| 3.9 | 2.8 | 2.9 | 3.1 | 3.2 | 3.3 | 3.5 | 3.6 | 3.7 | 3.8 | 4.0 | 4.1 | 4.2 | 4.4 | 4.5 | 4.6 | 4.7 | 4.9 | 5.0 | 3.9 |
| 4.0 | 2.7 | 2.9 | 3.0 | 3.1 | 3.2 | 3.4 | 3.5 | 3.6 | 3.7 | 3.9 | 4.0 | 4.1 | 4.2 | 4.4 | 4.5 | 4.6 | 4.7 | 4.9 | 4.0 |
| 4.1 | 2.7 | 2.8 | 2.9 | 3.0 | 3.2 | 3.3 | 3.4 | 3.5 | 3.7 | 3.8 | 3.9 | 4.0 | 4.1 | 4.3 | 4.4 | 4.5 | 4.6 | 4.8 | 4.1 |
| 4.2 | 2.6 | 2.7 | 2.9 | 3.0 | 3.1 | 3.2 | 3.3 | 3.5 | 3.6 | 3.7 | 3.8 | 3.9 | 4.0 | 4.2 | 4.3 | 4.4 | 4.5 | 4.6 | 4.2 |
| 4.3 | 2.6 | 2.7 | 2.8 | 2.9 | 3.0 | 3.1 | 3.3 | 3.4 | 3.5 | 3.6 | 3.7 | 3.8 | 3.9 | 4.1 | 4.2 | 4.3 | 4.4 | 4.5 | 4.3 |
| 4.4 | 2.5 | 2.6 | 2.7 | 2.8 | 3.0 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 3.6 | 3.7 | 3.9 | 4.0 | 4.1 | 4.2 | 4.3 | 4.4 | 4.4 |

Table 2.--Parallax factors by parallax (P) and focal length (when measured in inches)

| Parallax (P) or (P + dp) (inches) | Focal length of camera lens (inches) | | |
|---|---|---|---|
| | 6 | $8\frac{1}{4}$ | 12 |
| | Parallax factor (ho) in feet per 0.001 inch (dp) divided by PSR/1,000 | | |
| 2.0 | 0.250 | 0.344 | 0.500 |
| .1 | .238 | .327 | .476 |
| .2 | .227 | .312 | .454 |
| .3 | .217 | .299 | .435 |
| .4 | .208 | .286 | .416 |
| .5 | .200 | .275 | .400 |
| .6 | .192 | .264 | .384 |
| .7 | .185 | .255 | .370 |
| .8 | .179 | .245 | .358 |
| .9 | .172 | .237 | .345 |
| 3.0 | .167 | .229 | .333 |
| .1 | .161 | .222 | .322 |
| .2 | .156 | .215 | .312 |
| .3 | .151 | .208 | .303 |
| .4 | .147 | .202 | .294 |
| .5 | .143 | .196 | .286 |
| .6 | .139 | .191 | .278 |
| .7 | .135 | .186 | .270 |
| .8 | .132 | .181 | .263 |
| .9 | .128 | .176 | .256 |
| 4.0 | .125 | .172 | .250 |
| .1 | .122 | .168 | .244 |
| .2 | .119 | .164 | .238 |
| .3 | .116 | .160 | .233 |
| .4 | .114 | .156 | .227 |
| .5 | .111 | .153 | .222 |
| .6 | .109 | .149 | .217 |
| .7 | .106 | .146 | .213 |
| .8 | .104 | .143 | .208 |
| .9 | .102 | .140 | .204 |

### Table 3.--Parallax factors by parallax (P) and focal length (when measured in millimeters)

| Parallax (P) or (P + dp) (inches) | Focal length of camera lens (inches) | | |
|---|---|---|---|
| | 6 | $8\frac{1}{4}$ | 12 |
| | Parallax factor (ho) in feet per 0.01 millimeter (dp) divided by PSR/1,000 | | |
| 2.0 | 0.098 | 0.135 | 0.197 |
| .1 | .094 | .129 | .187 |
| .2 | .089 | .123 | .179 |
| .3 | .085 | .118 | .171 |
| .4 | .082 | .113 | .164 |
| .5 | .079 | .108 | .157 |
| .6 | .076 | .104 | .151 |
| .7 | .073 | .100 | .146 |
| .8 | .070 | .097 | .141 |
| .9 | .068 | .093 | .136 |
| 3.0 | .066 | .090 | .131 |
| .1 | .063 | .087 | .127 |
| .2 | .061 | .085 | .123 |
| .3 | .059 | .082 | .119 |
| .4 | .058 | .080 | .116 |
| .5 | .056 | .077 | .113 |
| .6 | .055 | .075 | .109 |
| .7 | .053 | .073 | .106 |
| .8 | .052 | .071 | .104 |
| .9 | .050 | .069 | .101 |
| 4.0 | .049 | .068 | .098 |
| .1 | .048 | .066 | .096 |
| .2 | .047 | .065 | .094 |
| .3 | .046 | .063 | .092 |
| .4 | .045 | .061 | .089 |
| .5 | .044 | .060 | .087 |
| .6 | .043 | .059 | .085 |
| .7 | .042 | .057 | .084 |
| .8 | .041 | .056 | .082 |
| .9 | .040 | .055 | .080 |